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Effect of Sawdust or Acid Application to Pen Surfaces on Nitrogen Losses from Open-Dirt Feedlots

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Applying sawdust to increase carbon on pen surface led to more nitrogen in manure and reduced nitrogen loss without affecting performance.

Summary

Two nutrient management treatments (sawdust or sulfuric acid application to pen surface) were compared to conventional management using 12 pens (10 steers/pen) to determine effects on performance and nitrogen losses from pens. Performance and carcass characteristics for treatments were similar to the control. The sawdust treatment retained more nitrogen in manure when removed from the pen surface and after composting. Increasing carbon by sawdust additions reduced nitrogen losses by 21%. Applying acid to the pen surface did not affect quantity of nitrogen or organic carbon conserved in manure and compost.

Introduction

Nitrogen is lost from the feedlot surface and during manure handling through volatilization. This nitrogen loss reduces the amount of nitrogen available to crops when manure is used as a fertilizer source. Plants require a nitrogen:phosphorus (N:P) ratio of 5:1 or greater; however, after substantial nitrogen loss the N:P ratio of feedlot manure is 2:1 or less.

Adding an additional source of carbon may improve the nitrogen retaining

properties of the manure on the pen surface and during composting. The addition of a carbon source, such as sawdust, widens the carbon:nitrogen (C:N) ratio of the manure. As the C:N ratio becomes greater, there is a tendency to retain more nitrogen.

The majority of nitrogen lost from feedlot manure is through volatilization. The pH where ammonia (form of nitrogen leading to volatilization) volatilization is greatest occurs above pH 9. Reducing pH below 5 can nearly eliminate ammonia loss.

The objective of this research was to examine the effectiveness of adding sawdust as a carbon source and lowering pen surface pH with sulfuric acid on nitrogen losses from feedlot manure and effects on cattle performance.

Procedure

One-hundred twenty yearling steers (672 ± 67 lb) were fed through the summer months for 132 days beginning June 14 and ending Oct. 16, 1995. Steers were initially implanted with Revalor-S and were randomly assigned to one of three treatments (10 steers/pen; four pens/treatment). Treatments were control, sawdust bedding application to pen surface and acidification of pen surface with sulfuric acid.

All treatments were fed the same diet formulated for 12% crude protein. Diet contained 80% dry-rolled corn, 10% alfalfa hay, 5% molasses and 5% supplement. Initial weights were an average of weights taken on two consecutive days following a five-day limit-feeding period. At slaughter, hot carcass weights were taken. USDA Quality grade and fat depth measured at 12th rib were recorded after a 24-hour chill. Final weights were calculated as hot carcass weight divided by a common dressing percentage (62).

Steers were fed in 12 open-dirt pens

with a pen density of 273 ft²/steer. Initial soil samples were taken to determine nitrogen and organic carbon percentage and pH. A pretest of experimental methods was performed to determine appropriate acid type and application rates, as well as amount of sawdust to be applied to the pen surface.

Before steers were introduced, the acid treatment pens were treated with sulfuric acid to initiate a pen surface between pH 4.5 and 5.5. Surface pH was monitored three to four times per week using one soil sample taken from four locations within each pen. Sulfuric acid was applied twice per week to regions of pens that measured above pH 5.5. An average of 1.3 moles/ft² (1 mol/L) was applied throughout the trial using a hand-held sprayer.

Sawdust by-product from a wood mill was added twice weekly to provide a 2:1 ratio of sawdust to fecal dry matter. Four-hundred sixty-five pounds of sawdust dry matter were added to pens each week. Sawdust was spread throughout the entire surface of each pen in the treatment at a rate of 0.17 lb/ft².

After steers were removed from pens, manure was scraped from the pen surface. Thirty manure samples were taken from each pen, and remaining manure was loaded onto trucks. An as-is weight was then taken and manure was hauled to a composting site. The manure was allowed to compost, and samples were taken after the composting process.

Manure and compost samples were frozen until analyzed at -20°C. Gravimetric water content was determined by drying for 24 hours at 105°C. Samples were analyzed for total nitrogen, ammonium (NH₄-N), nitrate (NO₃-N) and organic carbon content. Ammonium and NO₃-N analysis was conducted on moist samples while all other analysis was performed on air-dry samples.

Nitrogen intake (lb/steer) was calcu-

Table 1. Nitrogen balance.

Item	Treatment			P-Value	LSD ^a
	Control	Acid	Sawdust		
N intake, lb/steer	62.4	61.7	61.8	0.52	2.4
N retention, lb/steer ^b	7.3	7.3	7.3	0.84	0.2
N excretion, lb/steer ^c	54.4	54.5	55.2	0.72	2.4
Manure N, lb/steer	12.2	13.6	21.7	<0.01	3.5
N lost, lb/steer ^d	42.2	38.9	33.5	—	—
Compost N, lb/steer ^e	7.5	8.7	14.6	< 0.01	2.2
Organic carbon, lb/steer ^f	142	156	366	—	—

^aLeast Significant Difference (P=0.05).

^bDetermined using net protein gain equation (NRC,1996).

^cCalculated as N intake minus N retention.

^dCalculated as N excretion (lb/steer) minus manure N (lb/steer).

^eAmount of N in compost, measured with ash as a marker of organic matter disappearance.

^fDetermined by laboratory analysis.

Table 2. Nitrogen and organic carbon content of manure removed from feedlot pens and final compost product expressed in dry matter.

Item	Treatment			P-Value	LSD ^a
	Control	Acid	Sawdust		
Manure					
Manure wt., lb DM/steer	885	958	1795	<0.01	280
Total N, %	1.45	1.43	1.21	0.14	—
NO ₃ -N, ppm	34	23	80	<0.01	22
NH ₄ -N, ppm	685	1664	765	<0.01	449
Compost					
N, % 1.10	1.21	1.03	0.6	—	—
Organic carbon, %	8.6	10.1	14.60	.07	5.2

^aLeast Significant Difference (P=0.05).

lated as concentration in diet multiplied by dry matter offered minus nitrogen in feed refused times dry matter feed refused. Nitrogen retention (lb/steer) was calculated by using the net protein gain equation (NRC,1996). Nitrogen excretion (lb/steer) was calculated as nitrogen intake minus nitrogen retention. Nitrogen loss (lb/steer) was determined as nitrogen excretion (lb/steer) minus manure nitrogen (lb/steer). Amount of nitrogen in compost was measured with ash as a marker of organic matter disappearance.

Results

Yearling performance

In this trial, there were no statistical differences (P<0.10) between treatments in ADG (3.66 lb.), feed conversion (6.41) or hot carcass weight (727 lb.). The cattle on the sawdust bedding treatment showed a slight

decrease in fat depth (0.40 vs 0.48 in.) and USDA quality grade (17=S^o and 18=S⁺) compared to the other two treatments.

Manure nutrient data

Total manure weight removed in sawdust treatment was two times greater than acid or control treatments. The sawdust treatment resulted in the most nitrogen (21.7 vs 12.2 control or 13.6 acid, lb N/steer) being removed from the pen surface in manure (Table 1). Sawdust treatment reduced nitrogen loss by 21% compared to the control (Table 1). In previous reports (2000 *Nebraska Beef Report*, pp. 65-67), <5% of all nitrogen excreted is lost through runoff, therefore it is hypothesized that most of the nitrogen lost during this trial was through volatilization. Adding sawdust as a carbon source to the pen surface resulted in the most pounds of manure dry matter and the highest con-

centration of organic carbon. Nitrate concentrations were highest in sawdust treatment (Table 2) implying aerobic conditions were increased over other treatments.

Pens treated with acid had an average surface pH of 5.4, while sawdust and control pens were 8.0 and 8.2, respectively. Applying an acid treatment was not effective in reducing the amount of ammonia volatilized or in increasing organic carbon concentration removed in manure above the control treatment. One explanation as to why nitrogen loss was unaffected is urea (primary form of nitrogen in urine) raised pH for short times at certain locations within the pen. Some nitrogen may be unaccounted for in runoff.

Compost nutrient data

Composting reduced nitrogen concentration of all treatments by 25% with no effect of treatment on nitrogen concentration loss (Table 2). The sawdust treatment lost the least amount of nitrogen per pound of nitrogen composted, but lost the most nitrogen in terms of total pounds, because it contained the most nitrogen initially. The sawdust treatment continued to contain the most organic carbon compared to control and acid treatments.

In this feedlot trial, sawdust applied to the pen surface allowed increased nitrogen retention over the acid and control treatments. However, reducing pen surface pH to 5 did not affect performance and carcass characteristics or nitrogen and organic carbon retention compared to the control. Using sawdust as a bedding could be one way to help reduce nitrogen losses from open-dirt feedlot pens.

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